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The Improvement of Fodder and Forage in India

(Papers read before a joint meeting of the Sections of Agriculture and Botany, Indian Science Congress, 1923)

EDITED BY

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PREFACE

At the tenth session of the Indian Science Congress held at Lucknow in 1923, a joint meeting on the improvement of fodder and forage in India was arranged by the Presidents of the Sections of Agriculture and Botany. Two considerations influenced this decision—the first being the great importance of the subject to India, and the second the growing feeling among agriculturists that the time has come when the botanists should come forward and assist in solving these pressing problems. Great efforts are being made in all Provinces to improve the cattle, but the factor which limits such effort is the amount of fodder in the country. Improvement in the fodder supply must precede or at any rate go hand in hand with the improvement of the breed. As the best way of promoting co-operation is by a full discussion, this meeting was arranged so that the most urgent problems might be outlined. An invitation stating the aims of the discussion was sent to all Departments of Agriculture and as far as possible to all those who are interested in the improvement of cattle-breeding and dairying in India.

Although there is a great field for botanical work in fodder questions, it must not be forgotten that there are limits to what can be accomplished by plant breeding alone. There is not much hope of producing, either by selection, hybridization or introduction, the ideal fodder plant, namely, a crop which will give a large outturn of nutritious, succulent fodder with the minimum amount of water, which will thrive during that part of the year when all other vegetation ceases to grow and which can be easily preserved without loss or trouble. The evolution of such a type is probably beyond the powers of any botanist. Much, however, can be done by selecting better varieties of existing fodder crops, but the improvement will be one of degree only. A much larger field of investigation lies in the determination of the physiological needs of such crops and the consequent improvements in methods of cultivation. Another problem for the botanist is the discovery of the conditions necessary for seed formation in leguminous crops. Many of these such as lucerne, *berseem* and *shaftal* are most erratic in their seed production. The difficulty and expense of obtaining good seed is seriously hampering the extended cultivation of these valuable fodders.

The fundamental difficulties in the fodder problem, however, belong to the domain of economics and education. This was pointed out in several of the papers and at the joint meeting. It is only where the holding of the cultivator yields more than enough for himself and his family that he will give his cattle anything but a mere maintenance ration. The introduction of better varieties, better implements and increased irrigation facilities are all indirect methods of solving the fodder problem, and it is probable that the best solution will be found (where water is available) in the *intensive* cultivation of fodder crops on a small portion of the holding.

GABRIELLE L. C. HOWARD,
Chairman of the Joint Meeting
and President of the Section of Botany,
Indian Science Congress, 1923.

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The Improvement of Fodder and Forage in India.

(*Received for publication on 14th March 1923.*)

I GENERAL PAPERS.

1. SOME OF THE WIDER ASPECTS OF THE FODDER QUESTION IN INDIA.

BY

S. MILLIGAN, M.A., B.Sc.,

Agricultural Adviser to the Government of India.

The fodder question, like the cattle breeding question, is seldom properly understood in its wider aspects. In spite of the obvious fact that it is largely one of economics, there are many who consider that it can be solved by propaganda work. Such cries as "Encourage fodder production," "the people must put larger areas into fodder crops" assume that the cultivators wilfully neglect their cattle or that there exist large areas in India where crops can be grown purely for cattle fodder. The fact of the matter is that where holdings are large enough special areas *are* put under fodder, and the cattle *are* well fed and well kept. The great masses of the population in India, however, exist on small holdings. The cultivable area is devoted to and in most cases is just sufficient to meet the food requirements of the people, to pay rent or land revenue, and purchase the necessities of life, and it is the crop residues which form the main diet of the cattle of the country. This is to a certain extent true of other and more prosperous countries, but the extent to which crop residues form the diet of Indian animals is far greater than in most.

The reason, of course, is not far to seek. Animal industry, that is to say, the production of animal as distinguished from vegetable products, is less important in India than in most countries.

There is no beef eating, and dairying has yet to be developed in the arable districts, where it is practically non-existent except in favoured tracts such as Gujarat, the Punjab Canal Colonies, etc.

The crop residues referred to consist for the most part of the leaves and stems of the grain crops, the "cakes" produced in the oil pressing industry, and lastly, but by no means unimportant, the cotton seed after the lint has been extracted.

It will thus be readily realized that the cattle of the country are materially affected by improvements or the reverse in the staple crops of the country. It may be said at once, that, other things being equal, an improvement in the yield of these crops will be felt by the cattle just as much as by the human population. The growing of more efficient varieties of the staple crops, the improvement of yield by manuring or by improvements in cultivation, will effect a corresponding increase in the food of the cattle.

Conversely, the cattle may be adversely affected by a deterioration in the yield of the principal food crops, the growing of new varieties for grain purposes with no corresponding increase of straw, the growing of high lint percentage of cotton without an increase in total outturn of *kapas*, or the growing of crops yielding straw inferior as regards either food content or digestibility.

The importance of this point of view may be seen from the crop statistics of the country. Taking the average straw to grain ratios in the case of rice and wheat we find that the combined yield of straw from these two food crops amounts to not less than 90 million tons. per annum. The straw outturn from the 50 million acres of *jowar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*), and gram for food for human consumption runs into enormous figures.

Compared with such figures the amount of fodder grown specially for cattle feeding is relatively small. At the same time the importance of supplying green fodder as a mixing ration to straw is well understood and, wherever possible, grass, weeds, etc., are cut for this purpose. To some extent, especially in North-West India, cold weather leguminous crops such as melilotus, lucerne, etc., are grown as catch crops where the cover crop ripens too late to permit the growing of a *rabi* crop.

It is, however, the rice growing areas which are badly off for green catch crops, and it may be here noted that the smallest and worst conditioned cattle are found in these tracts. There the animals subside almost entirely on paddy straw supplemented by the scanty

stubble grazing available in the dry weather, and, in the rains, by what grass can be obtained from the field *bunds*, etc. The rice straw offers a bare subsistence ration for cattle at rest. As a working ration it is below par, and if it were not for the fact that the cattle in the tracts referred to have not more than a month's hard work in the year, *i.e.*, in the puddling season, the situation would be quite impossible.

The improvement of the cattle in the rice areas is admittedly one of the most important of problems which at one time appeared to be insoluble without cold weather irrigation. Recent work has, however, demonstrated the existence and importance of vitamines in the diet, and it now appears possible that the addition of quite a small quantity of the right class of green fodder to the rice straw ration might appreciably leaven the whole. The study of the value of different green crops for mixing purposes might thus yield valuable results applicable to the rice tracts. So long as the amount of green fodder required is small enough to permit of its being grown under well or tank irrigation, there need be no great difficulty for most cultivators to keep a very small patch of, say, lucerne or some such fodder going all the year round for the sake of the cattle. If, on the other hand, any considerable area is required, then the question can, as far as one can see, be solved only through increased irrigation facilities.

Apart from the general point of view of the maintenance of the working cattle of the country, there remains the important subject of dairying. This is the only form of animal husbandry in its true sense possible in an "agricultural" country with a vegetarian population. Commercial dairying is, however, only possible where plenty of green fodder is available during the greater part of the year. The rice tracts, therefore, are ruled out for this industry, but there remain very extensive high land irrigated areas where dairying is not only possible but ought to be profitable at the present rates for dairy produce. In these tracts the work cattle are on the whole good, but in many places a buffalo population for *ghee* making has sprung up and is now competing for the fodder—a state of affairs which can only be overcome by careful breeding of cattle for dual purposes of milk and draught. There is, however, a wide field for profitable investigation as regards the yielding power of different fodder crops in these areas, both for their relative feeding values and the economics of manuring. There is no more promising field so far as yield is concerned for manuring than in its application to the fodder crops.

Summarizing, I should therefore recommend to the Conference the special importance, from the point of view of the cattle of the country, of—

(1) The straw produced by the improvement in grain yields either through the new varieties, improved cultivation, or manuring, both as regards quantity and feeding value,
(2) The production of green fodder for mixing purposes,
(3) The production of fodder for dairy cattle.

2. THE FODDER NEEDS OF INDIA FROM A DAIRY POINT OF VIEW.

BY

W. SMITH,

Imperial Dairy Expert.

The agricultural needs of a country so vast as India with its diversities of climate, soil, rainfall and altitude must necessarily differ greatly in various localities, but throughout the country the cultivation of fodder will always primarily be for cattle feeding, and cattle feeding in India must eventually mean dairying, as the cattle breeder cannot go on perpetually rearing a cow simply to breed a bullock or another non-milk-yielding cow. Economic factors and the spread of general knowledge will force him sooner or later to adopt the dual purpose cow which will give him the class of bullock he needs and which will at the same time pay for her keep by her milk yield. It may, therefore, be assumed that the future needs of this country will be crops suitable for the feeding of milch cows. India cannot be cultivated without bullocks and bullocks cannot be produced without cows and all cows must yield some milk, the better they are the more milk they will yield.

The universal crying need of the country in connection with this fodder question is exact knowledge as to the most profitable fodder to be grown under given conditions. In view of the great importance of the improvement of the cattle of the country it appears to be an urgent necessity that the scientific agricultural services, particularly the botanists, should give much more time and attention to this subject than they have done in the past. I quite recognize that the botanists are few and that their time has hitherto been taken up with the staple crops such as wheat, cotton, rice and sugarcane, but it may be pointed out that none of these crops can be grown with the maximum of success without an efficient bullock, and an efficient bullock cannot be produced without suitable fodder for his growth and maintenance.

The object of this paper is, as far as possible, to indicate lines of research in connection with fodder production, which would give the country the knowledge most urgently needed. In attempting this it is, of course, impossible to deal with India as a whole. On the other hand, it is equally impossible in a paper like this to

take up every locality or district separately. I shall, therefore, deal in a general way with those parts of the country and systems of agriculture with which I am best acquainted.

The irrigated tracts of the Punjab form one of the largest and most important food-producing districts of the country. At present, a system of cropping is followed in this area which provides in the main for the growing of wheat, cotton, certain oil seeds and the leguminous crop gram. Very little is returned to the soil in the form of manure and in many areas leguminous crops are sparsely grown. That this system is impoverishing the soil is admitted by many authorities, and sooner or later the Punjab cultivator will be forced to fall back on some system of mixed farming (which will include stock rearing) to enable him to manure his land and retain its fertility. No doubt a certain amount of stock rearing takes place now on these irrigated tracts, but it is not taken into account in the system of crop rotation practised and provides little manure beyond the fuel (in the form of dung cakes) required by the cultivator. When the Punjab cultivator finds it necessary and profitable to take up cattle rearing as a real part of his business (and the sooner he does so the better for the country), he will require to know definitely the best fodder plants (leguminous and non-leguminous) to grow under the varying conditions prevailing in his Province. This knowledge can only be acquired after long research and years of experiment. I suggest that the work be taken in hand now.

In the rice-growing tracts of many parts of the country, particularly Bengal and Madras, the working bullock is fed on rice straw and such weeds growing on the *bunds* and among the rice stubble as he can pick up; the result is that he fares badly and is generally inefficient. I do not think that in the non-irrigated rice-growing areas it is possible to grow a second crop in the form of a catch crop following the rice, but there are irrigated tracts where this could be done, and if the crop grown were a leguminous one, and if, in addition to advice regarding the growing of the crop, the cultivator could be given exact knowledge concerning its conservation, either dry or in the form of silage, the result would be altogether beneficial. This, I consider, a profitable subject for research and experiment. In the non-irrigated rice-growing districts it is often possible to grow a fodder crop like *jowar* (*Andropogon Sorghum*) along the *bunds* dividing the plots, as is done in the Southern Mahratta Country. If paddy cultivators could be induced to adopt this practice wherever suitable, it would in no

way reduce the yield of rice and would greatly assist the cattle feeding problem. Here again it will be necessary to demonstrate the proper methods of conserving and storing the *kharif* grown fodder crops as well as to indicate the proper plant to grow and its method of cultivation.

In many parts of the country such as Sind, the Southern Mahratta Country, and parts of Mysore, large quantities of *jowar* (*Andropogon Sorghum*) are grown for cattle fodder, and it is my opinion that, generally speaking, the cultivators grow a type of plant suitable to the locality, but it is also my opinion that if these growers had sufficient knowledge to grow a suitable leguminous fodder crop from time to time on these lands and to look upon this as a regular part of their rotation, the general result would be greatly improved. The fertility of the soil would be maintained and the cattle fed on these leguminous crops would benefit by the addition of the increased albuminoid content of the fodder. The introduction of *berseem* into Sind by Henderson[1] is a good sample of what may be done in this direction.

Lucerne (*Medicago sativa*) is grown practically all over India. When fed green in moderate quantities it is a useful fodder for work cattle, young stock and dry cows. Cows in milk do well with small quantities of green lucerne, but for all classes of bovine stock it is an exceptionally good fodder in the form of hay. Howard[2] has already experimented with considerable success in making lucerne hay in the plains especially with an irrigated crop. I suggest that Howard's experiments in this direction be continued in several parts of the country, as the general use of well made lucerne hay would be of immense value to the cattle of India. Here, where generally speaking concentrated foods (grain) are either sparsely given or not fed at all to work and milch cattle, a dried fodder so rich in albuminoids and so appetising as lucerne hay is greatly needed.

In addition to the conservation of lucerne in the form of hay, the whole question of the preservation and storing of cattle fodders urgently calls for attention. In the monsoon, India produces enormous quantities of plants which, if harvested at the proper stage of growth, would provide nourishing and palatable feed for cattle, and which, for want of knowledge or general apathy, are

[1] Henderson, G. S. *Berseem as a new fodder crop for India*. *Agri. Res. Inst., Pusa, Bull* 66, 1918.

[2] Howard, A., and G. L. C. *The Agricultural Development of Baluchistan*. *Agri. Res. Inst., Pusa, Bull.* 119, 1921.

permitted to continue their growth until they are valueless. Not only so, but, especially in the case of the cultivators, the cattle are, long after the rains have passed, forced to eat the dry plants which they can little better, from a feeding point of view, than subsist. The conservation of plants of this kind and of many of the kohl fodder crops of India in the form of silage is a simple matter. Good silage can be made in most parts of the country by simply packing the succulent green crop into pits dug in the ground and covering the mass with earth. The siloing, drying and storing of fodder crops in India offers an immense field for experiment and research, and the country badly needs exact knowledge on this subject. India with its very wet and very dry seasons should regard the siloing of green crops as a standard method of providing feed for her live stock, but alas, the practice is, generally speaking, unknown in the country.

The foregoing brief paragraphs only touch the fringe of this vast subject, but it is the hope of the writer that they may stimulate the interest of scientific men in this important question.

3. QUALITY DEFICIENCY IN THE FODDER SUPPLY.

BY

COLONEL J. MATSON,

Assistant Controller, Military Dairy Farms, Second Circle.

The fodder deficiency in India is largely one of quantity, but by no means wholly. There is a great deficiency also in quality and notably in proteid matter. The quantity shortage induces supplements from the concentrated foodstuffs, which are relatively less scarce, but this increases the defects from the point of view of a correct and complete dietary in the matter of minerals and of the various food complexes sometimes called vitamines. The cow-keeping industry of the country suffers seriously in consequence. Much of the failure to breed and the production of weakly calves which die—so common in dairy cattle in India—is connected with this point. Nothing can take the place of leafy foods, preferably green, but otherwise shade-dried. I would like to lay the strongest possible emphasis on the value of green fodder in this country where we have no pastures which can be relied on every year to remedy the errors of previous stall feeding. Of leafy foods, certain of the *Leguminosæ* will supply many essentials in greater abundance than other fodder plants.

REQUIREMENTS IN IRRIGATED TRACTS.

In the irrigated tracts we need a leguminous fodder plant which will grow freely at the time when other crops are making their least demand on the water supply. We have not yet found what we require in this respect. Lucerne has its value but its water requirements are spread over too long a time and, in my experience, it is practically impossible to store it in India. This is peculiar In Queensland and the Argentine, I have found little difficulty on this score with unirrigated lucerne, more difficulty in Chili, where it was irrigated, but nowhere was it impossible as it is here. In the Punjab, I have succeeded in curing it in the field so that it would bear transportation to the stack or to the barn, though with difficulty, but even then I found it could not be handled for further transportation later. It breaks down to powder. The

plant structure when dried seems too fragile. Lucerne is also extraordinarily susceptible to alkali.

Berseem presents less difficulty in handling when dry but is not by any means easy to deal with. Again water has to be provided at the inconvenient moment. Nevertheless for certain localities it is the best crop yet found.

Shaftal is more easily grown in certain places, otherwise it has no advantages and is a poorer cropper.

I feel we want a plant *from among* those which *give only one* cutting but that a heavy one, which can be sown in March and harvested in May and June and of which the surplus can be stored. I suggest we must look to our botanical advisers to find it by varietal selection from among the cow peas and similar fodder plants. I speak of selection because some of these plants do not grow very well when sown in the *early* summer in the Punjab. It is true that plants of this class do not lend themselves very well to storage in the dry form, but a small admixture of *jowar* or maize enables the surplus to be stored as silage quite satisfactorily.

In the irrigated tracts of Northern India, the *kharif* pulses for the summer combined with soft turnips in winter will carry a larger head of stock on a given area than any other fodder combination known to me. Turnips are indeed far too much neglected as a cattle food. It is possible to arrange a succession from November to March, which is the particular season of green fodder scarcity at present. They give a larger outturn in weight than anything I know, up to 1,000 maunds per acre counting tops. As showing their value for dairy cattle, I may mention that in one of our Punjab farms we have lately (mid. November) begun thinning out the larger turnips and substituting these for *jowar* stalks in the cows' food, with the result that the milk yield within ten days has increased two pounds per head. These turnips are grown on a sandy soil by the aid of well irrigation in rotation with *berseem*, and we have had over 800 maunds per acre at the farm in question.

Requirements in tracts depending on monsoon rainfall.

In the non-irrigated tracts we want a leguminous fodder plant which will take the place of a fallow in the rotation, which is drought resistant and which gives its produce after the ordinary summer crops are off the ground.

For this purpose, I have met with some success with lucerne, in places where the rainfall is about 30—40 inches (mostly received

during summer) and where the soil is retentive of moisture without tending to crack seriously as it dries. Such conditions are met with in many localities in the United Provinces. (It should be noted however that a slight impregnation of alkali salts is fatal.) Lucerne sown on such land in September at the close of a good monsoon will give three to four cuttings between November and April. Moreover, it will then remain alive till the following monsoon and, if that is normal, repeat the performance. It will last, in my experience, until a year of deficient rainfall when a large portion will die. This is the most convenient time to change over and allot another field to lucerne. Sowing should be carried out as soon as the rain has been sufficient to give soil saturation. On the average a field of lucerne lasts for three years and must then be changed. Of course it fails to produce fodder in a year of scarcity when it is most wanted, but we cannot expect to find any plant that will grow without water. The gross weight of lucerne grown in this manner is not high. On an average of three years' productiveness some eight to ten tons of green fodder may be expected. It has, however, the following advantages:—

(1) When the food values calculated on the dry weight are compared with what would have been obtained from a similar area of a non-leguminous fodder crop, it will be found that the value is much higher than a comparison of the green weights suggests.

(2) It is obtained when no other green fodder is available and has a far higher value in consequence. An extra ton of green fodder in September, when grass is abundant, has little value, whereas a ton in February or March means a great deal.

(3) The crop rests the land almost as well as a fallow. The harrowing which may safely be given to such lucerne after each cutting will assist this and will be effective in keeping down weeds.

4. NOTES ON FODDER GROWING ON THE PUSA FARM.

BY

G. S. HENDERSON, N.D.A., N.D.D.,

Imperial Agriculturist.

The study of fodder crops is of great importance to India not only from the point of view of the general cattle question but also in regard to the extension of dairying. It is this aspect that has received most attention on the Pusa Farm. The data obtained have considerable practical importance, as the area concerned is large enough to be an economic unit.

It must be remembered that natural grazing in India is usually a delusion and a snare; when it is most wanted it is not there. From January to May the so-called grazing is represented by dried up, sunburnt plains on which the wretched cattle wander, trying to snatch a meagre mouthful in the arid fields.

It is necessary to provide a rotation which will not reduce the fertility of the land. From Table I it will be seen that the results of ten years' cropping on the Pusa Farm show no decline of fertility under the very intensive cultivation pursued.

The second table shows what fodder and grain has to be supplied for a dairy herd which averages 350 head with about a daily average of 80 cows in milk.

Mr. Hutchinson, the Imperial Agricultural Bacteriologist, has struck a timely note of warning in his address[1] to the Indian Science Congress at the meeting held in Bombay in 1919. He pointed out the danger of upsetting the delicate equilibrium which exists in the Indian ryot's cultivation between his crop yields and the available fertility of his land The principle also applies probably, to a large extent, to the introduction of modern implements. For dairy work, however, this does not apply. It is necessary to produce fodder crops and they must be produced by direct cultivation. It is hardly practicable to base a dairy scheme on fodder produced by tenants. It is absolutely essential to produce the fodder near the dairy herd. Fodder is a bulky article and will not bear transport. It is practically impossible to run a dairy scheme profitably if the fodder has to be bought in the open market. Now it is a very different matter indeed to run a block of land by means of tenants to cultivating the same area directly. This fact is very seldom appreciated. It is probably one of the greatest difficulties in the way of the extension of dairy work in India. Any considerable area of direct cultivation calls for expert super-

[1] *Agri Jour. India, XIV*, p 203

vision, suitable rotations and the provision of modern machinery and implements It is impossible to lay down general lines of guidance for all parts of India, each district would have to be settled according to its individual circumstances. The plan of cultivation on the non-experimental area of the Pusa Farm is quite useful as far as it goes, but would have to be modified very considerably in most cases. A short description will give the general principles underlying the plan of operations.

The main portion of the arable land consisting of some 413 acres is under the following rotation :—

	1st year	2nd year	3rd year
Monsoon crop (*Kharif*)	Maize for silage and fodder manured with 10 tons farmyard manure or oilcake at 10 md. per acre.	Maize for corn . .	Pulse green crop with 2 cwt. superphosphate.
Winter crop (*rabi*)	Oats . . .	*Rahar* (*Cajanus indicus*)	Oats.

This rotation entails much work at two periods of the year, but the heavy work is done by means of a set of Fowler's steam ploughing tackle and many of the subsidiary operations are carried out by tractors. There are also some 30 pairs of work bullocks chiefly used for transport purposes. The produce from the above area for the last ten years in given below :—

TABLE I.

Total return of grain and green fodder from 13 fields at Pusa for the last 10 years.

Year	Oats and other cereals in md.	Maize grain in md.	*Arhar*, paddy and other grain in md.	Total grain in md.	Green fodder maize, oats and peas in md.
1912-13 . .	2,210	522	891	3,620	16,301
1913-14 . .	1,997	200	1,100	3,297	11,513
1914-15 . .	1,749	534	1,704	2,987	14,127
1915-16 . .	2,660	881	1,701	4,254	30,903
1916-17 . .	2,897	670	932	4,499	31,971
1917-18 . .	2,376	1,276	1,010	4,662	30,893
1918-19 . .	3,380	1,559	1,037	4,982	30,735
1919-20 . .	2,479	1,061	719	4,262	31,621
1920-21 . .	2,512	766	1,073	4,381	33,359
1921-22 . .	3,764	1,267	1,132	6,163	34,492

Note—(1) 13 fields total 413 acres.
(2) Minor crops such as sugarcane and indigo are omitted.
(3) Straw in cereal crops is about double the weight of grain.
(4) 27 maunds are equal to one ton.

TABLE

Statement showing the quantities in maunds and the bullocks from 1st July 1921

Particulars	Cows	Young stock	Calves	Dry stock
Grain				
1. Oats	859	475	71	72
2. Pulses	585	290	76	35
3. Maize	417	245	81	41
4. Barley	61	15	...	...
Total grain	1,022	1,031	228	148
5. Oil cake	693	391	50	43
6. Linseed oil	...	...	9	...
7. Bran	...	...	8	...
8. Salt	53	62	17	11
Straw				
9. Oat straw	...	...	...	...
10. *Arhar bhusa*	...	...	...	...
11. Maize straw	...	...	...	...
Total straw	...	...	...	...
Green fodder				
12. Green oats and peas	...	...	...	...
13. Maize	...	...	...	...
14. *Jowar*	...	...	...	...
15. Pulses	...	...	...	...
16. Guinea grass	...	...	...	...
17. Sugarcane	...	...	...	...
Total green fodder	...	...	...	...
18. Silage	...	...	...	...

Average number of animals were—

1. Breeding herd	350
2. Farm bullocks	70
3. Estate bullocks	40
	460

II

particulars of feed for the dairy herd, farm and estate to 30th June 1922.

Bulls	Total for breeding herd	Farm bullocks	Estate bullocks	Grand Total	Farm produce	Purchased
91	1,508	296	171	2,038		
39	1,031	48	3	1,082		
70	851	321	158	1,330		
...	76	55	29	160		
200	3,520	723	361	4,616	4,616	
41	1,218	358	...	1,576	...	1,576
1	10	...	...	10	...	10
...	5	...	...	8	...	8
9	152	20	...	172	...	172
...	...	1,196	579	...	...	...
...	4,200	285	253	...	...	...
...	...	312	178	...	...	...
..	4,200	1,823	1,010	7,033	7,033	...
..	...	566	98	...	...	...
...	...	4,115	1,537	...	...	...
...	13,525	1,657	584	...	...	...
...	...	720	179	...	...	...
...	...	...	450	...	...	...
...	...	3,512	1,169	...	...	...
...	13,525	10,491	4,317	28,336	28,336	...
...	9,588	2,160	1,026	12,785	12,785	...

This statement does not agree with the outturn from 13 fields for 1921-22 because (1) the produce of experimental area is included in the present statement, (2) the grain from the cold weather harvest is used in season 1922-23.

In this year more oil cake than usual was purchased but this is counterbalanced by the sugarcane and non-fodder crops grown for experiment.

This 400-acre area is not irrigated but to bridge the gap from January to May some 40 acres of low-lying and formerly waste land have been levelled and put under irrigation. On this is grown *berseem* in the cold weather followed by maize in the hot weather. This reclaimed land gives a most valuable succession of green fodder. The cattle are tethered on the *berseem* and they follow on by grazing on the early maize. Pusa Bulletin No. 66 of 1916 gives details of this cultivation. They are kept on this *berseem* and the oat stubble until the break of the monsoon; thereafter the pulse crop in the main area is available for their grazing and on this and on the maize stubble they are kept till the *berseem* is again ready. Silage is made from the maize, cut green, and this with the oat straw is the main source of fodder which they get fed inside the sheds in addition to the outside grazing. Particulars of the grain and fodder supplied to the herd from July 1920 to June 1921 are given in Table II.

The cattle are thus not dependent on natural grazing. Cultivated crops are grown instead. There are some exercise fields, of about 100 acres in area, round the buildings which are laid down to *doob* grass (*Cynodon dactylon*).

What may be described as ranching, that is to say, the keeping of cattle on a large grazing area, is a very unsuitable system for dairying in India. The proper cultivation of suitable fodder crops is the only method of running a dairy herd properly.

From the rotation practised at Pusa it will be seen that maize, oats and some pulse crops are the chief items of cultivation. During the hot weather, one-third of the area is under maize for grain, another third is under maize cut green for silage and the remainder is cultivated with pulses as *guar* (cluster beans), cow peas, velvet bean, etc. All crops at Pusa are drilled and intercultivated by bullock implements thus reducing manual labour to a minimum. There are a number of other crops which in other circumstances could replace the maize in the rotation. *Jowar* (*Andropogon Sorghum*) will give a larger bulk of green fodder, but the silage is not nearly so good as the maize silage. Other more special crops are bamboo (*Dendrocalamus strictus*), some varieties of sugarcane, sunflower, *gonglu* or Punjab turnip and, where irrigation is available (say, the drainage from the cattle building), lucerne, Guinea grass. *Paspalum* and Rhodes grass are all useful. Field peas and green oats in the cold weather make a very useful mixture for feeding green.

The following results have been obtained with quantitative experiments on the yields of common pulses.

TABLE III.

Statement showing the average outturn for 5 years of kharif fodder pulses.

Kharif pulses	Average for 5 years of green fodder per acre in pounds
(1) Moth (*Phaseolus aconitifolius*)	15,770
(2) Velvet beans (*Stizolobium cinereum*)	12,440
(3) Cow peas (*Vigna Catjang*)	12,257
(4) Cluster beans (*Cyamopsis psoraloides*)	10,625
(5) Urid (*Phaseolus radiatus*)	9,999
(6) Soy beans (*Glycine hispida*)	7,836
(7) Florida beggar weed (*Desmodium tortuosum*)	4,174
(8) Val (*Dolichos Lablab*)	3,055

When maize grows really well there is nothing to approach it for a dairy fodder crop. At Pusa the green maize is cut in September, chopped up by a silage cutter and blown into a silo pit. The pits are large enough to hold between three and four thousand maunds of green fodder, and when they are full a plaster of mud is put on the top and the pit opens up in splendid condition. A hundred pounds of green fodder gives an average of 66 lb. of silage as weighed when fed to cattle. The other fodder stand-by is the oat straw and it can be fed "long," that is to say, as it comes direct from the threshing machine. The ideal method would be to feed the straw as it comes from the threshing machine on to the platform of the silage cutter and let it be cut and blown into the *bhusa* shed. It would then pack much better.

5. GRASSLAND ECOLOGY.

BY

W. BURNS, D.Sc.

Economic Botanist to the Government of Bombay.

Since 1911, the staff of the Economic Botanist, Poona, have been studying the wild fodder grasses. The following is a very brief account of the ecological side of our investigations.

The edaphic conditions of the Bombay Deccan are, from the point of view of geology, more or less uniform, since all the rock is trap and the derived soil is similar. From the point of view of ecology, however, the water-content makes a considerable difference even in soils geologically and chemically alike. The climate may be considered as uniform. At Poona, the average annual rainfall is 27 inches (between June and October), and during the hot weather the temperature ranges from 85° F. to 104° F. in the shade. A drying wind blows from the west during March, April and May. Its importance, undoubtedly great, has not yet been instrumentally measured. In a paper[1] read at the Calcutta meeting of this Congress in 1921, Chakradeo and myself gave an account of the first year's observations on a fenced-in seven-acre plot of the worst type of land in the above surroundings. This land was leased in 1920 and was at once fenced. It is therefore just three years since the inception of the experiment. One-third of the area (the middle strip) was ploughed and re-seeded with a mixture of good wild grasses, and the rest left untouched. The whole area has since then been left to itself, no further re-seeding having been done, while grazing, burning and cutting have been prevented. It was intended to watch the succession of vegetation that this area and climate would produce in the five years of the lease. Quadrats were charted in typical spots and recharted annually in October. Others were scraped or burned in order to watch the effect of these operations on selected spots. Our main observations so far are these:

(1) Re-seeding is not a success in this area. The breaking up of the ground in this, as in every other case which has come to

[1] *Jour of Indian Botany*, Vol. II, No 3, 1921.

our notice, results in a partial destruction of the existing grass cover, and in the appearance of a crop of ruderals. The seeds of these must lie dormant in the ground for considerable periods. In this area, *Vinca pusilla* was the predominant weed. Others such as *Glossocardia linearifolia*, *Polygala chinensis*, *Alysicarpus* and *Indigofera* species, and *Celosia argentea* were common. The appearance of ruderals when the existing cover is damaged is apparently a common phenomenon in other countries.

(2) Mere enclosure and the prevention of burning, grazing and cutting have, on the other hand, been very effective. The most striking result has been the development of the perennial grasses *Andropogon monticola*, *A. triticeus* and *Ischæmum laxum* on the hilly, rocky parts of the area. The tussocks of these grasses are rapidly increasing in size and number and are pushing out *A. contortus* which previously dominated. A casual inspection of any rocky part in the neighbouring country reveals all these grasses but never in tussocks of any size and always grazed flat to the ground. Given a chance, such as they have had in the fenced area, they will apparently increase enormously, and being perennial, a bad year now and again will not kill them.

(3) In the lower part of the fenced area, where there is deeper soil and where water is apt to lodge, we find a vegetation consisting of *Andropogon annulatus*, *A. caricosus*, *Ischæmum laxum* and *I. Wightii*, all dominant, with a very small proportion of the originally dominant *Andropogon contortus* left. In this area also survive the few descendants of *A. purpureo-sericeus* sown in 1920 in the cultivated strip.

(4) The succession in the worst areas appears to be the following one. *Nostoc* colonies, followed by the grasses *Oropetium thomaeum* and *Tripogon Roxburghianus*, form the first phase. Then follows a stage in which *Andropogon contortus* and such ruderals as *Evolvulus alsinoides*, and *Indigofera* species predominate. On the hilly and rocky areas, the next stage is dominated by *Andropogon monticola*, *A. triticeus* and *Ischæmum laxum*, as above described. Whether the area on rocky parts will ever get beyond this remains to be seen. Young *Acacia arabica* plants make very slow growth and a climax of this plant is likely to be long in coming. The soil on these areas contains in the first six inches about 14 per cent. of total water (ohresard), including both capillary and hygroscopic water, at the time when the majority of the grasses are in flower. This means 14 per cent. as calculated on the dry weight. Of the above only about 3 per cent. is capillary water.

(5) We are still not sufficiently informed from our experiments as to the effect of burning, nor have we studied the species minutely with reference to their adaptations for escaping fire damage. Since the area is not fired there is a large amount of dry straw lying about when the rains break. This is washed into heaps. Under these, vegetation is scanty or absent. While humus is thus added to the soil, there is a temporary and local check of vegetation in places where the humus pile is too deep. This is not, however, sufficiently general to be a serious objection to the prevention of burning.

(6) The establishment of tussocks of perennial grasses on the slopes of hills of shallow soil has undoubtedly begun to check erosion.

(7) The obvious difference between the grass inside and outside the fence, especially half-way through the rains, is striking. It is doubtful if the grass outside the fence (apart from the flowering clums) ever reaches two inches in height, being grazed down as it appears. In the most favoured parts of the fenced area the grass is five feet high, and on the rocky parts it averages two feet for the perennials.

(8) The close study which the investigation of a limited area demands has made clear to us that most of the wild grasses are represented by several sub-species. The writer is dealing with one of these (*Andropogon annulatus*) in another paper. *A. contortus* has shown two very marked sub-species, and other plants not grasses, notably *Evolvulus alsinoides*, show similar diversity of appearance.

In the estate of Government House, Poona, four plots differing in soil but all dominated by *Andropogon contortus* were selected, and treated by re-seeding with good wild grasses. In this case the existing cover was completely extirpated by ploughing and harrowing. The grasses used for re-seeding were *Andropogon caricosus*, *A. monticola*, *A. purpureo-sericeus* (as a nurse crop), *Ischæmum sulcatum*, *I. laxum*, *Thelepogon elegans*, and *Anthistiria ciliata*. No weeding was attempted after sowing and the land was roughly fenced with branches of *Acacia arabica*. The result has been the complete eradication of the old grasses and the establishment of a good stand of perennial grasses giving from 1,600 to 4,000 lb. of dry grass according to the nature of the soil. This grass was bought at Rs. 10 per acre by the neighbouring villagers. The only objection to this form of treatment is that on similar land the villager would probably raise a crop of *Pennisetum ty-*

phoidium. The trouble and expense of collecting the grass seed for sowing is also considerable.

Various other areas in the Presidency have been more cursorily investigated, but offer many intensely interesting and practical problems. For example, at Tegur in the Dharwar District with a rainfall of 40 to 50 inches, *Andropogon contortus* and *Anthistiria ciliata* grow in patches, mutually exclusive, but under similar conditions. We do not know what favours either. At Belgaum, on laterite soil, with an annual rainfall of 50 inches, there exists the finest grass land that the writer has seen. Here there seems to be little doubt that the occurrence of the endemic weed *Senecio belgaumensis* is an indication that over-grazing is taking place. At Kandivlee near Bombay with a 70-inch rainfall on soil derived from trap, we find grass land susceptible of improvement and in danger of being over-run with *Lantana*. At Ahmedabad, with a 29-inch rainfall and a high summer temperature, we find admirable grass-lands both on clay soil where *Ischaemum rugosum* dominates and on sandy loam where *Andropogon annulatus* is supreme. We are only at the beginning of such surveys, in which we shall attempt to correlate the species with their environment and see (as in the Deccan) what is the best that the environment will produce.

The impression left on our minds both from our experience in Bombay and from our reading of American, Australian and South African literature is that all grass-lands can be enormously improved in the first instance by rest until they recover from the abominable treatment to which they are normally subject, and thereafter by rotational grazing or cutting. It may be objected that this means either fencing or a greater degree of organization than the villager can attain. But we can quote the case of the village of Pimpalgaon Baswant in the Nasik District where about 300 acres of grass-land are administered by the village co-operatively on the old *panchayat* system. Annually 200 acres are set apart for grazing and 600 for cutting, giving enough and to spare for all the village cattle. Four watchmen at Rs. 10 to 12 per mensem were in 1915 kept for the six months when the grass was on the ground to prevent trespass. The problem is therefore soluble. Its scientific investigation is well worth while; its importance to agriculture, incalculable.

6. NOTES ON MAINTENANCE RATIONS.

BY

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In 1914, Murray of Reading published a formula by which the available energy requirements for oxen of any given weight might be accurately calculated. In this paper Murray's work has been extended, formulæ having been deduced for estimating the following additional requirements in the maintenance rations of oxen:—

(1) Total dry matter.
(2) Digestible crude protein.
(3) Digestible crude fat.
(4) Digestible nitrogen-free extract and digestible crude fibre.

It is very necessary to bear in mind that all feeding standards are simply averages and approximations. The tables given are for guidance only and not as infallible prescriptions invariable under all circumstances. To use them for calculating productive rations, *i.e.*, growth, fattening, milk secretion or external work, will be to invite disaster.

The requirements of animals from 2,000 pounds body weight down to 100 pounds body weight, by gradations of 50 pounds, are given in the attached tables. The two standards worked out are based on "Wolff's Original Standard" and Henry and Morrison's "Modified Wolff-Lehmann's Standard" for oxen on maintenance rations. Two sets of figures for maintenance rations have been worked out, because it will probably be found that the requirements for oxen and buffaloes are not identical. It may be found that Henry and Morrison's standard will be adequate for oxen, while Wolff's standard will have to be closely adhered to for buffaloes, but just how far the tables can be successfully applied to Indian feeding problems will only be satisfactorily settled after a number of prolonged experiments have been carried out.

While a ration may be chemically correct, it can be practically wrong. In such cases it is necessary to study the idiosyncrasy of the animal concerned, to endeavour to trace the factor or factors that are combining in such a manner that the animal in question is proving an exception to the general rule, and not blindly to condemn the chemists' work.

By the term maintenance ration is implied the food requirements of an animal which are sufficient for its maintenance in a state of so-called rest, *i.e.*, in a state of tissue equilibrium where it achieves no gain in body mass, nor excretes energy and tissue producing substances, nor performs work on its environment. It is obvious that this state is merely one of apparent rest for certain systems of tissues, for example, the heart must perform actual work unremittingly while the animal organism survives. It is most important to keep this conception in mind, for the requirements of the animal in a state of maintenance are wholly different, both in quantity and character, from those necessary for various classes of production.

In a ration supplied solely for maintenance purposes, the essential requirements are of the following order:—

(1) Fuel, to maintain a constant level of body temperature, and provide the energy required by the systems which function unremittingly for the performance of their work.

(2) Repair material in the form of nitrogenous organic material to replace the worn out tissue substance and inorganic salts to replace the small but continuously excreted quantities of these necessary products in animal metabolism.

With regard to the second of these desiderata it has been calculated that 0·5 pound of digestible protein is a sufficient amount of nitrogenous organic material to provide in the maintenance ration of an ox of 1,000 pounds body weight. However, it has been pointed out by numerous workers that it is not advisable to feed protein at the minimum experimentally estimated rate. McCollum and Simmonds state that certain phenomena observed by them in the course of feeding experiments, when animals were given quantities of the food essentials estimated to be adequate but only slightly above the minimum requirements in protein,

it may be true that the basal metabolism is not strictly proportional to, nor perhaps determined by, the surface area, the fact remains that it is more nearly proportional to this area than to any one factor so far discovered.

A large animal, for example, one of 1,000 pounds body weight, has relatively a smaller extent of body surface exposed than an animal of 100 pounds body weight, and consequently the loss of heat per unit of mass is greater in the smaller animal. The following illustration may help to make this point clear; a cubic foot of water weighs 62·3 pounds and has a surface area of 6 square feet; while a cube of water $2 \times 2 \times 2$ feet would weigh 500 pounds and have a surface area of 24 square feet only, *i.e.*, while the area has increased only four times the mass has increased more than eight times.

If the food requirements of animals of varying weights were in strict proportion to their body weight, and it be assumed that an animal of 1,000 pounds body weight requires that quantity of food whose value may be expressed as β. then an animal of 1 pound would require ($\beta \div 1{,}000$, and for one of ψ pounds the formula would be $\psi \ \beta \div 1{,}000$). We have seen, however, from the studies of Rubner, Richet and E. Voit that the food requirements of animals of varying weights do not follow the line of strict proportion, therefore the simple formula given above must be discarded. It has been proved that animals of tenfold mass have approximately only five times the radiating surface; this, taken together with other facts of a similar kind, would indicate that their food requirements will bear a like relationship. So the simple formula must be amended. When the body weight is less than 1,000 pounds something must be added to the proportional amount and when greater something must be deducted. Another method of expressing the above conclusion is to state that when the mass is increased tenfold the food should only be increased five times and *vice versâ*.

The bulk of the maintenance rations supplied to farm animals may be made of roughages. Where the roughages are of exceptionally good quality, concentrates will not be required.

The logarithm formulæ and simple formulæ deduced and used in the preparation of tables given with this summary will, it is hoped, be published in the near future.

TABLE I.

Wolff's Standard.

BODY WEIGHT	TOTAL DRY MATTER	DIGESTIBLE NUTRIENTS		
		CRUDE PROTEIN	CRUDE FAT	NITROGEN FREE EXTRACT AND CRUDE FIBRE
Pounds	Pounds	Pounds	Pounds	Pounds
	A	B	C	D
100	3·4	0 148	0 029	1·58
150	4·6	0·197	0 039	2·10
200	5·6	0 243	0 048	2·59
250	6·6	0 284	0 056	3·02
300	7·5	0 322	0 064	3·43
350	8·3	0·359	0 071	3·83
400	9·2	0 395	0 078	4·20
450	10 0	0 428	0 085	4·56
500	10·7	0·461	0 092	4·92
550	11·5	0·493	0 098	5·25
600	12·2	0·524	0·106	5·58
650	12·9	0 555	0·110	5·91
700	13·6	0 584	0·116	6·22
750	14·3	0·616	0·122	6·53
800	14·9	0 641	0·128	6·83
850	15·6	0 669	0 133	7·12
900	16·2	0 696	0·139	7·42
950	16·8	0 723	0·144	7·70
1000	17·5	0 750	0 150	7·09
1050	18·1	0 776	0 155	8·26
1100	18·7	0 801	0 160	8·54
1150	19·3	0 827	0·165	8·81
1200	19·8	0 852	0 170	9 08
1250	20·4	0 877	0 175	9·34
1300	21·0	0 901	0 180	9·69
1350	21·5	0 925	0 185	9·88
1400	22·1	0 949	0 189	10·11
1450	22·7	0 972	0 194	10·38
1500	23·2	0 996	0 199	10·61
1550	23·7	1·020	0 203	10·86
1600	24·3	1·042	0 208	11·10
1650	24·8	1·065	0 212	11·34
1700	25·3	1·087	0 217	11·58
1750	25·8	1·110	0 221	11·82
1800	26 4	1·132	0 226	12·06
1850	26·9	1·154	0 230	12·20
1900	27·4	1·176	0 235	12·52
1950	27·9	1·198	0 239	12·76
2000	28·4	1·218	0 243	12·98

TABLE II.

Modified Wolff-Lehmann Standard.

Body weight	Total dry matter	Digestible nutrients		
		Crude protein	Crude fat	Nitrogen free extract and crude fibre
Pounds	Pounds	Pounds	Pounds	Pounds
	A	B	C	D
100	3·3	0·138	0·010	1·38
150	4·5	0·184	0 026	1·84
200	5·5	0·227	0 032	2·27
250	6·4	0·265	0 037	2·65
300	7·3	0·300	0 043	3·00
350	8·1	0·325	0 047	3·25
400	8·9	0·368	0 052	3·68
450	9·7	0·400	0 057	4·00
500	10·4	0·431	0 061	4·31
550	11·1	0·460	0 065	4·60
600	11·8	0·489	0·069	4·89
650	12·5	0·518	0·074	5·18
700	13·2	0·545	0 077	5·45
750	13·9	0·577	0·081	5·72
800	14·5	0·598	0 085	5·98
850	15·1	0·624	0·089	6·24
900	15·7	0·650	0 092	6·50
950	16·4	0·675	0 096	6·75
1000	17·0	0·700	0·100	7·00
1050	17·5	0·724	0·103	7·24
1100	18·1	0·748	0·106	7·48
1150	18·7	0 772	0·110	7·72
1200	19·3	0·805	0·113	8·05
1250	19·8	0·818	0·116	8·18
1300	20 4	0·841	0·119	8·41
1350	20 9	0·861	0·123	8·61
1400	21·5	0·885	0·126	8·85
1450	22·0	0·908	0·129	9·08
1500	22·5	0 929	0·132	9·29
1550	23·1	0·951	0·135	9·51
1600	23·6	0·972	0·138	9·72
1650	24·1	0·994	0·141	9·94
1700	24·7	1·014	0·144	10·14
1750	25·1	1·036	0·147	10·36
1800	25·6	1·056	0·150	10·56
1850	26·1	1·076	0·153	10 76
1900	26·6	1·101	0·156	11·01
1950	27·1	1·118	0·159	11·18
2000	27·6	1·137	0·162	11·37

II. PAPERS ON LEGUMINOUS FODDERS.

7. SOME PROBLEMS OF FODDER PRODUCTION IN THE PUNJAB.

BY

COLONEL E. HEARST COLE, C.B., C.M.G.

The production of leguminous fodder in large quantities in the Punjab, for the purpose of feeding stock as cheaply as possible and for the improvement of arable and pasture lands, is a matter of such importance that I venture to call attention to it. In this way only is the discussion and exchange of views possible, so that we can advance our knowledge and bring about practical improvements.

The stud farm at Colevana in the Montgomery District of the Punjab is now worked on the following six-year rotation:—

(*a*) Grass two years.

(*b*) Crops two years—in the *rabi*—oats, *shaftal* (*Trifolium resupinatum*) and *berseem* (*Trifolium alexandrinum*); in the *kharif*—*chari* (*Sorghum vulgare* Pers.), *guar* (*Cyamopsis psoraloides* DC.), *moth* (*Phaseolus aconitifolius* Jacq.) and maize.

(*c*) Lucerne two years.

In this rotation, the grass leaves plenty of organic matter for the cereals (oats, *chari*, and maize) and the crops clean the land for lucerne which in turn leaves the soil rich in nitrogen for the grass. Stable manure is given to the grass-lands but there is not nearly enough of this to go round. This year, the light lands have been green-manured with *guar* and *sunn* (*Crotalaria juncea* L.).

Lucerne is drilled in lines on clean land and is kept free from weeds by running the country plough down the lines when the plant is about six inches high. I have not yet been able to find a harrow which will do this work. After the first cut, the country plough is run down again and then the crop is cross-harrowed with a spring-toothed cultivator. I cut the crop with a mower, as manual labour is much too expensive. In the cold weather months, when the outturn of lucerne is small, the cost of collection and

cocking is heavy as the horse-rake cannot pick it up easily. The cost of labour is also increased by the fact that the lucerne takes several days to dry. In the hot weather, the crop is heavy and can be collected and dried in about thirty hours. The loss in dryage in the cold weather is very great. I estimate that ten maunds of green lucerne yield one maund of hay. In the hot weather, the loss is less and one maund of hay is obtained from five maunds of green stuff. Lucerne usually seeds well at Coleyana. This year (1922) rain fell in early June and spoilt a large amount of lucerne kept for seed. The average yield of seed obtained in a normal year is about one maund of cleaned seed per acre. In 1921, about three acres of land was ploughed up and tail seed of lucerne broad-casted with some *dhaman* seed (*Pennisetum cenchroides* Rich.). Here the lucerne has done much better than I ever expected and is now making quite a fair show in the grass. Next season, if I get sufficient lucerne seed, I intend to disc my new grass paddocks heavily, where the roots are not matted, and put down the spare lucerne seed. I am of opinion that it will not only improve the feeding value of the paddocks but gradually improve the grasses and incidentally add the necessary bacteria to the land by the time the paddocks come into the lucerne rotation.

Shaftal. On the advice of Mr. Howard, I put down *shaftal* in 1918 procuring seed from Bannu and Quetta which, however, was very impure. In that year, I simply broad-casted the seed on the flooded grass-lands. It came up fairly well and gave valuable feed for my horses, but we were able to raise only a few seers of seed. The grass was distinctly improved in quality by the *shaftal*. I have now come to the conclusion that it is better to disc the grass-land and even cross-disc before broad-casting the *shaftal* seed. This is done with the International tandem disc cultivator and tractor. The outturn of *shaftal* is considerably increased and the subsequent grass crop is much improved. Early in April when this grass-land *shaftal* is over, the lands are again disced to open up the soil and help the grass forward. I do not expect to get seed from *shaftal* sown in this way.

I have tried for several years to obtain seed from this crop when sown in well-worked lands but without success. About the middle of April, the leaves of *shaftal* turn red and the plant seems to get scorched; once this occurs, it appears to be useless to attempt to help it by watering, in fact the crop seems to me to behave like American cotton. If a very regular and plentiful supply of water

can be given and the *shaftal* can be kept from getting red leaf, I believe one could get seed. I intend to try this on a four-acre plot of very good land this year.

The cost of *shaftal* seed varies from Rs. 22 to Rs. 32 a maund for an article which contains about forty per cent. of impurities. If this very necessary fodder is to succeed in the Punjab, some means of growing our own seed must be discovered. We get three to four cuts a year and then lay up the crop for seed.

Berseem is a very good fodder, yielding one maund of hay for every nine or ten maunds of green crop. I think, on the whole, it is a better fodder than *shaftal*. It grows well and gives certainly three cuts on well prepared land, but again the difficulty is to procure seed, though it is easier than in the case of *shaftal*.

The seeding of these fodders—*shaftal*, *berseem* and lucerne—is greatly affected by the season. Last season (1922) was evidently a bad seed year, as Bannu and Peshawar were very short of *shaftal* seed; but we do not know why the seed formation is affected by the season. Normally, I expect to produce lucerne seed fairly easily, but we have to learn how to make *shaftal* and *berseem* form seed, and until we can do so, growing them on an extended scale is not possible. Provided the seed difficulty can be overcome, *shaftal* and *berseem* should replace *senji* (*Melilotus indica* and *M. alba*) in these parts. *Senji* only gives one cut and is not nearly such a good crop for the land as the other two, but it has one advantage, it needs less water. In any attempt to replace *senji* by *shaftal* or *berseem*, one must be prepared to gamble on the water supply. If it is short, one will lose and get a small outturn, with winter rain and a fair supply of water, there will be a distinct advantage.

There are several indigenous leguminous plants in the Punjab, which I consider might be made more use of as fodder. One of these—*Rhynchosia minima* DC.—which grows among cotton and climbs up the cotton stems has attracted my attention. Horses eat it greedily. I am trying a small plot this season. The seed germinates in September and is ready to cut in January. *Rawari* (*Lathyrus Aphaca* L.) a kind of vetch which grows in wheat and lucerne might also be useful.

In Kashmir, I found a small wild variety of lucerne growing on hard rocky soil on the southern face of the Takht near Srinagar, and was able to secure a little seed which I hope will germinate at Coleyana. This might become useful on grass-land. In

Srinagar, Gulmarg and in the Sind valley, there is a large amount of what I believe to be wild white clover. Unfortunately, I was unable to procure any seed as it was too unripe to pick. A large quantity of seed of noxious plants such as thistles is brought down from the hills by the rivers and the plants thrive luxuriantly in these parts. Sometimes chicory is brought down. If such seeds can come and live, perhaps useful plants might be acclimatized. If we can induce the wild white clover or the wild lucerne of Kashmir to live and spread on our grass-lands, it would help matters very greatly. Some years ago, I put down a small quantity of Sutton's white Dutch clover. This survived one hot weather.

Lucerne, *shaftal* and *berseem* can all be made into very valuable hay, but the dryage is great—eighty-to ninety per cent.—so it is more economical to feed green. In my case, however, hay is a necessity, and I dry and stack at once all green fodder not fed off. I have baled some very good lucerne and *shaftal*. These hays have to be very carefully handled in moving from the stack, as all the leaf, the most nutritious part, must be saved. I therefore have it carried to the feeding trough in sacking.

What we require badly in this country is more information on the feeding value of the principal indigenous forage plants such as *doob* (*Cynodon dactylon* L.), *dhaman* (*Pennisetum cenchroides* Rich.), *jhanewah* or *palwan* (*Andropogon annulatus Forsk.*) and *chimbari* (*Eleusine flagellifera* Nees). *Chimbari* is the local indigenous grass in this locality and existed on the dry-lands long before the advent of the canals. It must be remembered that this Montgomery District has produced one of the finest breeds of cattle in India and these existed entirely on this grass. *Chimbari*, however, is a rains grass and seems to die off under irrigation, being replaced by *dhaman* which again gives place to *jhanewah* (*palwan*). Both *dhaman* and *jhanewah* give way when *doob* appears.

I had great hopes of being able to form permanent pastures on my irrigated lands, but the number of weeds brought down by the canal water makes me very doubtful regarding the possibility of this. Some of my pastures have become so foul from weeds that ploughing up has become imperative. Heavy discing seems to improve matters considerably. I would very much like to hear of the experience of others regarding this question.

8. AN IMPROVED METHOD OF LUCERNE CULTIVATION.

BY

ALBERT HOWARD, C.I.E., M.A.,

Imperial Economic Botanist.

The pressure on the area of land at the disposal of the Botanical Section of the Pusa Research Institute, has suggested intensive cultivation as a partial solution of the difficulty of growing the large amount of seed required as well as the fodder needed by the work cattle. Several crops, including lucerne, are being studied with a view of discovering the best methods of intensive cultivation by which the largest possible yield can be raised from a small area. Afterwards, further improvements, by the methods of the plant breeder, can be undertaken. The results so far obtained prove conclusively that real success in fodder growing depends very largely on a knowledge of the morphology and physiology of the plant cultivated as well as on the selection of suitable varieties. It seems probable that fodder growing in the future in India will split off from general agriculture and become a specialized branch of the subject. Large quantities of fodder are required in India near the large cities for feeding buffaloes and cows, work cattle and horses. In such localities, land is scarce and dear. Green fodder is bulky and expensive to transport so that it cannot be produced successfully at great distances from the centres of population. The difficulties of supply can be met, in part at least, if really large crops can be obtained from a small area. The results obtained with lucerne at Pusa indicate that a solution of the urban fodder problem by means of intensive agriculture is quite feasible.

Lucerne, as is well known, is an important perennial fodder crop and is cultivated all over the world wherever the soil and other conditions are suitable. Both the green fodder and the hay made from it are rich in albuminoids especially if the leaves are preserved. The following analyses of lucerne hay made at Quetta show how important it is to preserve the leaf,

TABLE I.

Analyses of Quetta lucerne

	Baled lucerne (leaves intact)	Lucerne ropes (leaves partially destroyed)
Moisture	3·14	5·00
Ether extract (fats)	3·32	2·00
Albuminoids	15·48	11·71
Soluble carbohydrates	46·30	43·87
Woody fibre	17·70	27·05
Soluble mineral matter	11·83	8·10
Sand	2·23	0 47
Total	100 00	100 00
Albuminoid nitrogen	2·48	1·87
Total nitrogen	2·98	2·19
Albuminoid ratio	1 : 3·5	1 : 4·3

Besides a high albuminoid ratio, lucerne has another great advantage when grown in the plains. It yields abundant fodder in March, April, May and June and again in November and December when other green food is scarce. This is a great help to the Indian ox, whose existence can be described as one of short commons with interludes of abundance.

The choice of variety is a very important matter in lucerne cultivation. The first trials at Pusa were made with Kandahar seed. This variety is admirably suited for the high temperature of the frontier valleys but it does not grow well at Pusa during the cold weather. The well known Hunter valley lucerne of Australia was then tried next to seed obtained from the seed farm at Kalianpur near Cawnpore. Both did exceedingly well, but the Kalianpur variety proved the better of the two.

The usual method of growing lucerne in Bihar is on ridges with channels between for irrigation. The disadvantages are that the yield is low, the volume of irrigation water required is very

large, a good many weedings are necessary and the plant dies out during the hot weather probably on account of the baking of the surface and the high soil temperatures. This system has been given up and lucerne is now grown on flat beds, two feet wide with irrigation channels, one foot wide, between the beds. The seed is sown on the beds and in the irrigation channel as well, so the stand appears to be continuous and no bare ground is visible. This increases the yield, preserves the texture of the soil, saves a large amount of water, and also reduces the cost of weeding. Further, the stand survives the hot weather and the rains and is efficient for a second year's growth. The plants in the trenches, however, die out during the rains. The heavy monsoon of 1922, which amounted to 62·30 inches at Pusa, had no harmful effect on the lucerne grown on flat beds. In the rains, the irrigation channels act as drains and greatly assist in maintaining the aeration of the soil.

The yield of green fodder obtained by the flat bed system is very large. A plot sown on October 20th, 1921, gave eight cuts up to July 11th, 1922, at the rate of 70,000 lb. to the acre. The manure applied was 20 maunds of powdered rape cake to the acre. Such a result, however, is little more than a beginning and it is expected that the number of cuttings and the total yield will be considerably increased by the application of light dressings of leaf compost (made on the Chinese system) to the beds and trenches. The first results obtained by this treatment promise well. The increase was about fifty per cent.

The intensive cultivation of lucerne needs water. How can this be obtained in ordinary practice? This question has already been answered. At the Bangalore meeting of this Congress in 1917, a paper was read entitled *The agricultural development of North-West India* in which it was suggested that the water necessary for the extended growth of leguminous fodders—such as lucerne, *shaftal* (*Trifolium resupinatum*), *berseem* (*T. alexandrinum*) and *senji* (*Melilotus indica* and *M. alba*)—could be obtained by using less water for wheat. This subject has since been further developed in Bulletin 118 of the Pusa Institute entitled *The saving of irrigation water in wheat growing*.

One of the greatest advantages of lucerne in the plains is that it can be made into excellent hay which is easily stored for use in the rains. I have here two samples of lucerne hay, made by the staff at Pusa in the ordinary routine, one which has been kept

loose for two years, the other made last month. It will be seen that the colour is good and that there is no loss of leaf. The great thing to prevent loss of leaf in hay making is to turn the crop when there is a certain amount of dew on it and to complete the curing process in long heaps made with the butts outward and the tips towards the centre. After the hay is made, it can be stored or carried direct to the chaff cutter and the chopped hay mixed with *bhusa*. The *bhusa* serves to protect the lucerne from loss of leaf during storage and subsequent handling.

The baling of lucerne hay for Army transport purposes in a dry climate like that of the Quetta valley is not an easy matter. It can, however, be accomplished by damping the lucerne over night and covering it with a tarpaulin. If fed into the press just at the right stage, the bales keep without damage. The great thing is to use the minimum amount of moisture needed to prevent powdering. An easier way of baling in such localities is to put the damped lucerne hay through a chaff cutter and mix the product with *bhusa*. The mixture is easily pressed. I have here samples of lucerne pressed in both these ways taken from bales made in 1918. Since that date the bales have been kept at Pusa on an open verandah.

There is one difficulty which will have to be solved before crops like lucerne and *berseem* can be taken up by the people. This is the seed supply. At present seed is dear, scarce and often unsatisfactory. Lucerne sets seed to some extent in the Punjab and the United Provinces but very little seed formation takes place at Pusa. The difficulties with regard to the seed supply of *berseem* are even greater. The conditions necessary for seed formation in these crops are being worked out at Pusa and the results will be published in due course. Once the seed supply can be arranged, the cultivation of these important fodder crops should spread rapidly in many parts of India.

9. FODDER GROWING IN RELATION TO COTTON CULTIVATION.

BY

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The function of leguminous rotation crops in maintaining fertility in India, where so little is done in the way of manuring, is not always fully realized. The cultivator in most parts of Northern India, however, has learnt this principle by experience, and in the United Provinces and Bihar it is undoubtedly a most important factor in determining his rotations. In the United Provinces, *jowar* (*Sorghum vulgare*) and in Bihar, maize, are largely grown mixed with *arhar* (*Cajanus indicus*), while in many parts of India the growing of *arhar* with cotton is extremely common. In the United Provinces and Bihar, the recuperative effect of the deep-rooted *arhar* crop is probably an important factor in determining the area of maize and *jowar* grown, since the leguminous crop develops after the grain crop is removed.

The most marked case of the maintenance of fertility in cotton cultivation by the use of a leguminous catch crop is, however, seen in Egypt where *berseem* (*Trifolium alexandrinum*) grown with cotton is a general feature of the agriculture of the country. In Egypt as in India, the destruction of organic matter in the soil takes place rapidly, and in both countries organic manure is scarce but, unlike India, the cotton yields in Egypt are by far the highest in the world.

One of the recommendations in the *Report of the Indian Cotton Committee* was that more attention should be paid to leguminous catch crops in cotton growing tracts. In most parts of Northern India, *berseem*, *shaftal* or *senji* all grow well and yield very profitable crops of fodder of enormous value to both work and milch cattle at a time when the ordinary fodder available is wheat *bhusa* or barley straw or the dry stalks of the millets—none of which can be called highly nutritious. The practical difficulty usually met with in any attempt to increase the area under such catch crops is the supply of irrigation water. All these crops in the early stages of their growth require considerable amounts of water at a time

when the demand for water, particularly for wheat, is high. The canal supply being limited in most cases, the problem resolves itself into either putting smaller areas under wheat in order to grow leguminous fodders or raising the wheat crop with less water. In some tracts both of these measures would be sound, in others one is limited to the second. It is probable that in new canal colonies the present system of agriculture includes too large an area under wheat in each year, and that an equal production of wheat could be obtained on a smaller area with better cultivation and a smaller expenditure of water. In the older canal tracts, there is less reason to believe that the area devoted to wheat growing is excessive but there is still room for economy in watering. Many years' results at the experimental farms in the United Provinces, particularly at Cawnpore and Shahjahanpur, have shown that with proper timing, heavier wheat crops than the average cultivator has ever dreamt of can be raised with two-thirds of the water which he generally uses. With a more efficient use of canal water, both the yield per acre and the yield per cusec of irrigation water could be materially increased. The water saved could be used for leguminous fodder crops which in turn, by helping to maintain soil fertility, would further increase the dividend on the water used, whilst the better feeding of milch and work cattle thus made possible would raise the whole standard of village life. The secret of the economical use of irrigation water is timely application, and this involves either control of the water, as when a cultivator has his own well, or certainty as to when it will be available. The distribution of water in a large canal system is no simple matter. Progress would probably be more rapid were the water requirements of the various crops better understood. The problem of the future will not be to irrigate the largest area per unit of water, nor even to raise the most revenue, but to get the greatest return in agricultural produce.

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10. EXPERIMENTS WITH LUCERNE IN THE PLAINS OF SYLHET.

BY

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Economic Botanist to the Government of Assam.

Preliminary experiments on the growth of lucerne appear to show that this crop can be successfully grown in the well-drained soils of Assam. It is hoped to continue these trials.

III. PAPERS DEALING WITH SPECIAL TRACTS.

11. THE FODDER PROBLEM IN TRAVANCORE.

BY

N. KUNJAN PILLAI, M.A., B.Sc., Ph.D.,

Director of Agriculture, Travancore, and President of the Section of Agriculture, Indian Science Congress, 1923.

Travancore, like the rest of India, is essentially an agricultural country. The State has a population of a little over four million, and of these nearly three-fourths are dependent upon agriculture. The total area of the State is about four and a half million acres of which nearly two million acres are under cultivation. The uncultivated lands lie mostly in the inaccessible interior parts of the country and consist to a great extent of reserved forests. The littoral and sub-montane tracts, where there are extensive systems of water and road communications, have been almost completely brought under cultivation. These regions are also the most thickly populated portions of the country. The density of population in Travancore is 525 to the square mile, whereas it is only 177 in India and 454 in the United Kingdom. Practically the whole population lives in the littoral and sub-montane tracts, and it is there that agriculture has also developed to the largest extent.

The cattle population of Travancore according to the last census is about 893,000. This gives an average of 20·2 head per 100 acres of the total area and 45·2 per 100 acres of the cultivated area. Compared with the United Kingdom and other Western countries this is a somewhat high proportion. The major portion of the cattle population in Travancore, as in the case of the human population, is confined to the littoral and sub-montane tracts where most of the lands are occupied by food crops like paddy or commercial crops like coconut and where there is hardly any pasture for cattle. Cultivation of fodder crops is not in vogue in any part of Travancore and stall-feeding is only rarely practised. There is only one fodder which is common throughout the country and that is rice straw. Its nutritive value is much less than that of *jowar* or maize stalks, and yet this is the one fodder which maintains practically the

whole cattle population in Travancore. Plough cattle and cart bullocks are occasionally given some cotton seed, horse-gram or tamarind seed. But this is considered a luxury which is indulged in only by the well-to-do farmers. The lack of sufficient pasture, the absence of fodder crops and the inability of the cultivators to stall-feed their cattle are the chief factors that contribute to the deterioration of cattle on our coast. In addition, the climate is against us. The heavy rainfall, which ranges from 80 to 200 inches and more, is not conducive to the healthy growth of cattle. No wonder then that the cattle on the Malabar coast are thin, puny little creatures hardly able to pull even a good indigenous wooden plough. Before any attempt is made to improve the breed of cattle it is essential to solve the fodder problem.

Various experiments are being conducted by the State Agricultural Department with a view to arrive at a solution of this problem. The cultivation of *jowar* has been tried, but it does not grow well on inferior laterite soils, and there is no good land available for the cultivation of fodder crops. Moreover, if *jowar* is cultivated at the commencement of the monsoon the growth becomes stunted on account of the heavy downpours, and if cultivated towards the middle or close of the monsoon the crop does not as a rule mature without artificial irrigation which is neither practicable nor profitable in Travancore. The next attempt of the Department has been to grow grass on lands which are not fit for the cultivation of ordinary crops. There are a number of local species of grass growing wild on waste lands, but they are rather coarse and the yield is comparatively small. During the hot season, which lasts for about five months, all these grasses dry up. The Department has, however, experimented on the cultivation of Guinea grass, and this has proved a success. It grows even on poor land and the growth is luxuriant if some farmyard manure is applied to the soil. If irrigated it will grow throughout the year and one cutting can be taken every month. The average annual yield of fodder will then amount to fifteen to twenty tons per acre. In Travancore irrigation is rather difficult and hence the crop has to depend upon rain alone, in which case about seven to eight cuttings can be taken in a year and the yield will average about twelve tons per acre. Guinea grass is a good fodder for all cattle and particularly for milch cows. It contains about nine per cent. of carbohydrates and 3·5 per cent. of proteids and has an albuminoid ratio of 1 : 6. The cultivation of Guinea grass is being encouraged by the Agricultural Department and is being taken up by the people.

Prickly-pear grows wild in some parts of Travancore, and the possibility of utilizing it as fodder has been investigated by the Agricultural Department. A feeding experiment with prickly-pear was conducted last year with distinct success. The variety tried was *Opuntia elatior*. Ten dry cows were fed with it for a period of five months. It contained 0·5 per cent. of ether extract, 14·25 per cent. of carbohydrates and 1·9 per cent. of proteids with an albuminoid ratio of 1 : 8. The thorns were first burnt over a smokeless fire and the unburnt portions were pulled out with pincers. Prickly-pear, thus freed of its thorns, was cut into small pieces and mixed with some cotton seed. The mixture was ground and was then fed to cows. For the first few days the cows showed some reluctance to eat the stuff, but later on they began to like it and ate it quite well. At first, each cow was given 3 lb. prickly-pear and ½ lb. cotton seed. Gradually the quantity of prickly-pear was increased until it reached 10 lb. per day. One cow alone developed diarrhœa. The rest had no trouble whatsoever and they maintained their condition and health well. Besides prickly-pear and cotton seed, the cows were given as much rice straw as they could eat. The cost of collecting and preparing prickly-pear came to one anna per head per day, and the price of straw and cotton seed to about 2 annas per head per day. Thus, at a cost of 3 annas per day it was found possible to maintain a dry cow in good condition by feeding her with prickly-pear, a small quantity of cotton seed and as much straw as she could eat. Prickly-pear is, therefore, a cheap and efficient fodder. Its use ought to be more widely known, and wherever it is available it ought to be fed to cattle. One great advantage of prickly-pear is that it grows even on the poorest lands in the driest regions. There is also a thornless variety of prickly-pear. A few plants of this variety have been procured and are being grown by the Agricultural Department. If on experiment this variety is found to be a good fodder, it is proposed to recommend its cultivation on all waste lands which cannot be used for the cultivation of ordinary crops.

12. THE IMPROVEMENT OF FODDER AND FORAGE IN THE COIMBATORE DISTRICT.

BY

K. UNNIKRISHNA MENON,

Assistant Director of Agriculture, Madras.

The District of Coimbatore is an agricultural tract which has the benefit of both monsoons. It possesses extensive dry lands (containing a good percentage of lime) as well as forest areas. The District is distinguished for its breed of cattle which supplies draft animals to a very considerable portion of Southern India. Sir Frederic Nicholson estimated the number of horned animals in this District as 900,000 in 1885. The number must be at least a million now. Taking 18 pounds of straw as the average daily consumption of an animal, 3 million tons of dry fodder would be the average annual requirements of the District. The area under cereals and pulses is 1·855 million acres and, at half a ton per acre, the straw obtained will not exceed one million tons. The balance of two million tons has, therefore, to be made up. The one and one-third million acres of forest area in the District is not all grass-land, nor is grazing available there for more than four months in the year. Further, all the cattle in the District cannot be driven into these areas. The meagre supply of weeds cut from the *bunds* of wet and garden lands or removed from dry lands is negligible. Thus there is a pronounced deficiency of fodder. The extension of the area under money crops like cotton and castor has added to the difficulty. The practice of leaving the margins of garden and dry land for pasture has gradually given way under the stress of an increasing population and the pressure of cultivation. That the ryot strives his best to tend his cattle is, however, undeniable. In order to supplement the low quantity of bulky fodder available, he feeds cotton seed and oil cake to his work and milch animals while they are serviceable. The shortage of bulky fodder is also partly met by growing varieties of *Sorghum*.

The following suggestions for the relief of this condition of fodder scarcity seem possible of execution. Some of the land under well irrigation should be used to grow an off-season cereal fodder

crop. It is time that the intelligent ryot should make up his mind to give up a precarious and uncertain seasonal grain crop and grow a fodder crop of *Sorghum* in its place. To increase the vegetative growth of such a crop the field should be fairly well manured, the crop should be sown very thickly, and care should be taken to choose the right variety for the season. In the case of a fodder famine, it is necessary to grow a short duration fodder crop even though it is less prolific. For this purpose a fodder crop of *teff* grass (*Panicum miliare*) or the like may be used. Crops which are almost perennial like Guinea grass should also claim a portion of the garden land, the extent of which can only be decided by the available irrigation facilities. It would not matter much if this grass were to oust some of the poorer grain crops. Guinea grass has yielded about thirteen tons per acre per year for over nine years on the College Farm at Coimbatore. Another useful crop of this sort is the newly introduced Elephant (Napier) grass which even on poor lands has yielded more than thirty tons per acre per year. These two grasses may very conveniently be raised on river banks and thus serve the double purpose of supplying fodder and preventing erosion. Lucerne stands a good chance of extension in garden cultivation as, while supplementing the fodder supply, it can be used as a substitute for a portion of the concentrated food now given.

In dry lands, under present conditions, it is not feasible, except by voluntary effort or by education, to limit or reduce the area under the non-fodder-yielding money crops. There may be cases where a ryot would be well advised to leave the land fallow for grazing in preference to raising an unremunerative grain crop.

The cultivation of pulses like *Phaseolus aconitifolius*, cow-gram, *Dolichos Lablab*, etc., as mixtures with more exhausting grain crops like *Sorghum*, might be encouraged. Some of the American varieties of cow-gram do well as fodder crops and they also tend to enrich the soil. In the poorer soils, however, horse-gram is the best fodder crop. These pulses should be cut when the pods are full grown and the stems no longer succulent and difficult to dry. The practice of sowing *san*-hemp in a standing wet land paddy crop a few days before harvest to serve both as a green manure and a fodder is also worth recommending. In almost all conditions *san*-hemp grows well after paddy. After the first cut is taken for fodder, the stubbles sometimes yield another crop which can be ploughed in as manure. Even if the growth from the stubbles is not heavy owing to an unfavourable season, the roots imbedded in the soil have added considerably to the fertility.

There are hardly any pasture areas worth mentioning now left owing to the encroachment of cultivation, and it is impossible to satisfy the popular cry that Government should create facilities for increasing the grazing areas. The demand might to some extent be met by reviving the practice of granting the concession of grass *pattas* for lands under dry assessment. This consists in a concession of assessment of one-fifth in the total dry area the ryot owns. The enjoyment of this reduced assessment is not for a particular piece of land but is given if the ryot puts one-fifth of the dry area into grazing. This custom was prevalent as late as 1880. To devote some land mainly to grazing purposes may seem uneconomical, but the fact that it gives the land a fallowing which affords opportunities for recouping the fertility might be taken into account. If the same piece of land also sustains a number of farm animals, it has served two, by no means insignificant, purposes. Provided land is available, it is also advisable to grow white *Acacia* trees to provide shade and stray pods for cattle. While these trees yield both fuel and wood for implements, the presence of a few of them scattered in a field does not prevent the occasional growth of a purely dry, yet economical, grain crop. Such dry lands, when taken up for cultivation, might be sown with some slow-growing grass seed in addition to the grain. *Kolukattai* (*Pennisetum cenchroides*) is a useful crop of this class.

13. ELEPHANT GRASS OR NAPIER GRASS (*PENNISETUM PURPUREUM*).

BY

K. UNNIKRISHNA MENON,

Assistant Director of Agriculture, Madras.

The usual crop grown for fodder in Madras is *cholam* (*Andropogon Sorghum*). Different varieties are popular in different tracts, namely, *Irungu* in Tinnevelly, *Periyamanjal* in Coimbatore, *Cheruku Patcha Jonna* in the Telugu districts. *San*-hemp and horse-gram are occasionally found as fodder crops in some parts of the Presidency. Of the many exotic crops tried, Guinea grass for some time seemed the best perennial fodder. Trials were, however, made later with other varieties of grasses and the results obtained so far show that Elephant grass is very promising. It has been found to grow well in comparatively poor land where Guinea-grass failed to give good cuts. The growth depends, however, upon the manuring given, and this factor determines the number of cuts per year.

Elephant grass is a native of Rhodesia, and experience on the Central Farm, Coimbatore, shows that it is best propagated by slips. A well-manured soil of good tilth is necessary for its successful cultivation. The best plan is to divide the field into ridges and furrows three feet apart. The slips, each with some roots attached, must be planted three feet apart in the row on one side only of these ridges. The crop can be irrigated by means of the furrows. A certain amount of weeding must be given in the early stages When the grass has grown sufficiently thick and high to cover the ground, it suppresses and checks the growth of weeds. Thirty to fifty cartloads of cattle manure per acre to the land is a moderate application. Subsequent manuring may be given at the rate of ten to fifteen cartloads per acre twice or thrice a year. With a fairly satisfactory supply of water, a cut can generally be taken every two months. It is wiser to cut the stump as close to the ground as possible, at the most three inches above ground. This makes the tussocks stronger and better rooted. After every cut, the crop must be inter-cultivated with a country plough both ways. This operation will necessitate remaking the furrows;

but it promotes rapid growth. The grass should be cut when it is just in flower, and the fodder so obtained can either be dried and stored as hay or used as green fodder with any other dry fodder the ryot may have. A ryot would be well advised to put a portion of his land permanently under this crop instead of using large areas of good land for occasional short duration fodder crops. Replanting may be required once in four or five years.

Slips can be had from the Central Farm at almost any time of the year. Five thousand slips are required to plant an acre. The yields obtained are about 34,220 lb. per acre per cut, which is much higher than the yield of a *cholam* or Guinea grass crop in the short growth period. As regards the nutritive value of the crop, analysis shows that Elephant grass hay contains 8·81 per cent. albuminoids and 31·73 per cent. digestible carbohydrates as against 3·23 per cent., and 39·20 per cent., respectively, in Guinea grass hay. It is much relished by cattle.

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14. SOME SUGGESTIONS FOR THE IMPROVEMENT OF FODDER AND FORAGE IN THE MADRAS PRESIDENCY.

BY

M. RAJHAMI,

Officiating Deputy Director of Live Stock, Madras.

Cholam (*Sorghum vulgare*) is the best of the cultivated fodder crops, and among the varieties of this crop *Periyamanjal* from Coimbatore is the most promising. This may be the original *Pedda Jonna* of the Ongole tract. The need of a study of the fodder grasses is very great, and more advantage of leguminous crops should be taken. It is suggested that more use might be made of the common weed *Phaseolus trilobus*.

15. THE FODDER PROBLEM IN THE CENTRAL PROVINCES.

BY

D. CLOUSTON, C.I.E., D.Sc.,

Director of Agriculture, Central Provinces.

In the Central Provinces, there are three fairly well defined agricultural tracts, namely, the cotton tract, the rice tract and the wheat tract. In the cotton tract, the fodder question is not a serious one. The grazing areas being very limited, the cultivator is obliged to grow *jowar* (*Andropogon Sorghum*) on a large scale as fodder for his cattle. His animals are largely stall-fed, and he knows exactly how much bulky fodder in the shape of *jowar*, and concentrated food in the form of cotton seed, *tur* (*Cajanus indicus*) husk, etc., they get from day to day. His draught cattle are relatively big and strong and his standard of cultivation relatively high in consequence. In years in which *jowar* is a partial failure he generally manages to supplement the supply of this fodder by carting grass from the forest or fuel reserves in his *tahsil;* and in famine years such as that experienced in 1920 he is prepared to pay for baled grass railed from other districts. He realizes the importance of stall-feeding in short, and makes a point of storing fodder for his cattle. The analyses of *jowar* stalks and other feeding stuffs used in this tract, of wheat and rice straw (which are the bulky fodders mainly used in other tracts) and of silage, Egyptian clover, lucerne, etc., in use on Government farms are given in the table below. The analyses were carried out by Mr. Plymen, Agricultural Chemist.

The various constituents are shown as percentages on the weight of the food:—

TABLE I.

Composition of the various cattle foods used in the Central Provinces.

	Moisture	Oil	Protein	Carbo-hydrates	Fibre	Ash	Sand in ash	Food units
Bulky foods, dry.								
Mixed fodder grasses .	8 24	1 52	3 30	43 99	32 54	10 41	7 80	56
Wheat straw . . .	8 93	1·18	2 98	41 02	31 61	14 25	10 04	51
Rice straw . . .	10 01	1 21	3 09	39 38	29 89	16 43	12 69	50
Jowar stalks (*Karbi*) .	6 14	0 89	2 89	58 42	25 37	6 20	3 08	68

TABLE I—*concld.*

	Moisture	Oil	Protein	Carbo-hydrate	Fibre	Ash	Sand in ash	Food units
Bully foods, dry—concld.								
Fodder *jowar*	12 69	1 09	4 20	34 55	38 38	9 10	3 82	48
Gram (*phol*)	9 79	0 20	2 93	26·50	16 77	3 76	0 12	44
Lucerne hay	6 09	2 02	15 20	43 30	21 83	9 56	0 53	86
Clover hay (*Berseem*)	6 01	2 63	12 14	46 24	22 03	10 95	1 44	81
Egyptian clover (*Berseem*)	81·63	0 51	3 22	8 26	4 00	2 38	0 15	18
Lucerne	75 00	0·54	4 05	11·31	6 31	2 51	0 11	21
Silage from fodder *jowar*	17 51	1 09	7 67	36 76	29 89	7 17	2 00	58
Concentrated foods.								
Cotton seed	7·79	19 67	19 81	33 22	18 83	3 68	0 17	124
Cotton seed cake undecorticated	10 23	5 07	18 97	38 38	22 03	5 52	0 72	96
Cotton seed cake decorticated	7 63	12 51	31 80	21 00	6 18	7 70	0 95	149
Linseed cake	5 05	10 76	31 94	30 21	7·87	6 35	1 25	117
Groundnut cake	7 38	4 02	52 87	25 01	3 62	6 12	1 46	109
Till cake	5 75	11 35	40 81	25 11	5 18	11 81	0 97	156
Tur dhanl	7 75	2 22	20 98	48 52	12 55	7 98	2,51	107
Jowar meal	12 31	2 50	7 60	73 82	1 66	2 02	0 17	99

From the above it will be seen that wheat straw, rice straw and fodder grass are fairly similar in food value and inferior to *jowar* stalks (locally known as *kadbi*). It is interesting to note, too, that the feeding value of our grasses is much below that of the varieties found in Europe and America.

TABLE II.

Composition of the common grasses of the Central Provinces and Berar.

Name of grass	Moisture	Oil, etc	Total nitrogen protein	Soluble carbo-hydrate	Crude fibre	Ash	Including true protein	Including sand
Ischæmum sulcatum	7 78	1 38	3 56	35 75	35 35	16 58	3 10	14 59
Apluda varia	7 09	1 82	3 91	40 30	35 52	11·09	2 98	9 39
Setaria glauca	7 68	1 75	4 11	43·14	30 02	13 00	3 29	10 16
Iseilema laxum	1 16	1 25	2 89	48 96	31 13	10·59	2·41	8 30
Andropogon annulatus	10 94	1 70	2 09	11 57	31 18	8 46	2 00	6 33
,, *caricosus*	7 89	1·03	3 89	15 77	32 10	8 81	3 17	5·43
,, *pertusus*	10 57	1 83	3 95	47 1	28 02	7 55	2 70	3·03
Iseilemum laxum	8 81	1·20	2·97	42 92	34 01	10 10	2 35	8 06
Andropogon contortus	6 07	1 06	2 00	50·13	32 01	7 23	1·76	5 02
Average	8·24	1·52	3 30	44 00	32 54	10 41	2·60	7·80

TABLE III.

Composition of the grasses of Europe, America and Australia.

	Ether extract	Total nitrogen as protein	Nitrogen free extract and soluble carbo-hydrate	Crude fibre	Ash
United States. . .	3·14	9 21	53·07	25·71	7·97
Germany . . .	2·34	10 71	46·53	34·09	6·30
Queensland . . .	1·93	13·39	49·73	22·53	12·42
New South Wales . .	2·14	9 03	52·81	29·35	6·67

The fodder problem is not a very serious one in the cotton tract though there has been a tendency to increase the area under cotton at the expense of such fodder-yielding crops as *jowar* and wheat; the area under the latter crop has been very largely reduced within the last 30 or 40 years. The high prices paid for cotton has greatly encouraged this. In the more fertile parts of the tract the tendency has been, too, to give up the rearing of cattle and to buy draught bullocks reared for sale in Indian States, or in districts in the wheat tract of the Province where land is of much less value, where grazing areas abound, and where the rearing of cattle for sale is an economic proposition.

In the cotton tract there are no irrigation facilities worth mentioning; *jowar* which is a rain-fed crop is the most profitable fodder crop for the cultivator to grow. The Department of Agriculture is assisting him to increase his yield by giving out seed of improved varieties. Cultivators are also being advised to grow groundnut in rotation with cotton and *jowar*; groundnut enriches the soil for the succeeding crop and supplies at the same time a profitable return of nuts and good feeding stuff for cattle in the form of stem and leaf. The making of *jowar* silage is another innovation which the Deputy Director of Animal Husbandry is now trying to introduce. The Department is also advocating the use of oil cakes in place of cotton seed, and the demand for the former has increased considerably in recent years as a result of our propaganda.

Experiments were carried out several years ago to ascertain whether it would be possible to grow some of the best local grasses

in rotation with the staple crops of the tract. Seed of these grasses was collected and sown in plots which had been carefully manured and cultivated. The results obtained showed that none of the grasses tried was ever likely to take the place of *jowar*, for *jowar* yields more fodder per acre and gives in addition a valuable food-grain. It is thus a dual-purpose crop supplying as it does food for the bullock and the man who works it. In this tract there are unfortunately no irrigation facilities except from wells, and well irrigation is expensive. With irrigation good crops of Egyptian clover (*Trifolium alexandrinum*) can be grown; on some of our Government farms heavy yields of this luscious fodder are being raised year after year by irrigation from tanks. The first cutting is obtained in December and the crop continues to give cuttings till late in April. Clover is usually grown as a second crop; it does very well after rice when sown towards the end of the monsoon, ten days or a fortnight before the rice crop is harvested. The soil, at that time, is still sufficiently damp to germinate the seed. By lying in contact with moist soil the seed germinates in four or five days, and the young plant is well established in a fortnight, by which time the rice is ready for harvesting. Clover sown in this way does better than that sown in open fields which have had to be cultivated before sowing. This would appear to be due to the fact that in its early stages the young clover plant thrives best when shaded from the hot glare of the October sun.

In the Chhattisgarh Division which constitutes the greater part of the rice tract, there are large stretches of level but very poor lateritic soil locally known as *bhata*. Most of the grazing areas in this division consist of this *bhata* soil on which the only grass that thrives well is *sukla* or spear grass (*A. contortus*); but the feeding-value of *sukla* is low and its yield poor. An attempt was made by the Department to introduce better grasses such as *Ischaemum sulcatum*, *Ischaemum laxum*, *Andropogon annulatus*, *A. caricosus* and others which thrive in black soil. The *bhata* land selected for these experiments was cultivated and the roots of *sukla* were killed as far as possible before the seed of the better varieties was sown. The latter did not thrive well, however, and the area was soon overrun again by this inferior but hardier grass which would appear to be well adapted for shallow dry soils of this class. *Sukla* is not only inferior in quality, but is a short season grass which makes very little growth before the beginning of September. It starts flowering in October and produces sharp spikelets commonly known as spears. Being a slow grower it is a poor pasture grass, as it

provides little or no grazing in the early part of the rains when the cattle are emaciated and when other fodder is very difficult to obtain. If not grazed or cut before the middle of October, moreover, the spears formed injure to some extent the mouths and throats of the animals which eat it. An experiment extending over three years was carried out on one of these *bhata* plains to ascertain how far the feeding value of this grass could be improved by cutting it before the middle of October, *i.e.*, before the spears formed. To make the experiment thoroughly practical ten young animals about one year old were brought from cultivators in surrounding villages and fed entirely on *sukla* grass. In addition to grazing they were given *sukla* grass hay which had been cut by mowers early in October and *sukla* grass silage stored in pits. In three years these ten young animals had developed into useful draught bullocks which were much superior to those of the same age in the villages adjoining. The experiment proved conclusively that, when cut before the middle of October, *sukla* is an edible and fairly good fodder. Cattle fed continuously on it advanced much faster than did those of the ordinary village cultivator who neglected stall-feeding and whose animals had to subsist on something less than a maintenance diet for the greater part of the year. The failure of the average cultivator to provide his growing stock with a maintenance diet during the dry weather accounts very largely no doubt for their being so small and weak. It accounts, too, for the heavy mortality among cattle in villages in the early part of the rains when death is often due to their gorging themselves in rice fields in which they are allowed to graze at this season. If the cultivator were to take the trouble to store *sukla* grass hay to tide them over this critical period he would have much better cattle and fewer deaths among them.

The fodder problem is undoubtedly a serious one in this tract where rice straw is the principal fodder and where there is not even enough of that to satisfy the hunger of the large herds kept in every village. The Department is trying to get the comparatively large and useless grazing areas in this tract brought under the plough wherever they are commanded by irrigation from Government tanks or canals. So long as such areas are kept for grazing, large numbers of useless cattle will be retained. No attempt will be made to provide for the storage of fodder or to use wood instead of cowdung for fuel. In many cases these useless animals are maintained mainly for producing fuel in the form of cowdung and they share with the cattle required for agricultural purposes the

very inadequate supply of food available in the form of pasture and rice straw. Big but poor grazing areas in short result in many inferior cattle being kept; inferior cattle result in bad cultivation, and bad cultivation results in poor yields and weak, half-starved draught bullocks.

For poor soils which cannot be irrigated, the small bamboo (*Dendrocalamus strictus*) is a useful fodder. This bamboo is easily established and thrives very well on the light well drained *bhata* soils of Chhattisgarh. The seed is first sown in a nursery and the seedlings are planted out in the beginning of the rains. In the third year after planting out they give a yield of from 40 to 60 tons of leaf per acre. The bamboo, moreover, gives a large quantity of green leaf in the very beginning of the rains when other green fodder is conspicuous by its absence. Of the most important constituents of food, *viz.*, protein, oil and carbohydrate, dry bamboo leaves contain nearly four times as much protein as is contained in the common grasses. In the green state the leaves are greedily eaten by cattle.

In the wheat tract the condition as regards grazing facilities are more or less similar to those of the rice tract; but in this tract there are, in addition to the area reserved for grazing, large stretches of deep fertile soil overrun with *kans* grass (*Saccharum spontaneum*). The land has lain fallow for many years, and provides a certain amount of grazing for the village herds. *Kans*, however, is one of the least palatable of possible cattle foods and is not worth including in the category of fodder grasses. Fields of tall *kans* grass may be seen even in the beginning of the hot weather, a clear indication of the fact that it is not liked by cattle. In this tract so little attention is paid to the storage of fodder that *jowar* stalks are generally left standing in the fields, the heads only being removed to the threshing floor. That the cattle problem is a serious one may be gathered from the fact that large areas are allowed to lie fallow because the draught bullocks are not sufficiently strong to plough the land when once it becomes infested with *kans*. The cultivators as a whole do not appreciate the importance of keeping strong draught bullocks and fail therefore to make adequate provision for fodder though *jowar* and *bajra* can be grown successfully in the lighter and better drained soils. Here, as in the rice tract, the area available for grazing is too large. No real steps are taken to grow and store fodder and the cultivator is encouraged to keep more cattle than he actually needs. What is badly wanted is an increase in the area under crops such as *jowar*

and *bajra* and the cultivation by mechanical power of the large *kans*-infested areas of this tract. By means of motor tractors *kans* can, in one season, be eradicated and the land is left ready for the cultivation of wheat, gram and other *rabi* crops, nearly all of which supply the grower with food for his bullocks in one form or another. Government is, as far as funds will permit, encouraging landholders to reclaim their lands from *kans* by offering *takavi* loans for this purpose under the Land Improvement Loans Act. A start has already been made in this direction, and we hope that at no distant date thousands of acres of rich wheat land lying fallow at present will be producing food for man and beast. The motor tractor and kerosene will supply the motive power required for cultivation and will, by increasing the fodder supply, enable the cultivator to increase his bullock power.

The whole problem of how to improve the efficiency of draught cattle in the Province is bristling with difficulties owing to the attitude of the people concerned. Even educated men who play an active part in public life make the mistake of opposing the slaughter of useless cattle and of demanding that the grazing area should be still further increased. If this policy is to be adopted the problem will become still more difficult, for what is urgently required is an improvement in the quality and a decrease in the number of cattle maintained: but any great improvement in the quality is well-nigh impossible so long as the cultivator relies as much as he does at present on grazing as a means of subsistence for his cattle.

16. THE FODDER PROBLEM OF THE UNITED PROVINCES.

BY

RAI BAHADUR L. C. SHARMA, M.R.A.C.,

Deputy Director of Agriculture, United Provinces.

There is a great scarcity of fodder and grazing throughout these Provinces even in a normal year. Thus the problem we have to deal with at present is not that of high feeding but the mere maintenance of the required number of cattle in working condition from year to year, together with the provision of a reserve to meet a fodder famine.

The following is a short summary of the existing practices. All available waste lands are utilized for grazing. In every large village certain lands are set apart for this purpose by common consent, but as each individual cultivator is anxious to increase his holding, and the zamindar wishes to expand his rent roll, a gradual encroachment is constantly taking place. In some places the inhabitants of a village have jointly taken a lease of the common grazing lands and find this very advantageous. Such a practice might be considered by the Co-operative Societies. In congested localities, individual cultivators reserve some land for grazing in the form of a temporary fallow but generally the stubbles left after the harvest and some coarse grazing form the main food of the cattle. Low-lying lands enriched by annual inundations yield luxuriant crops of *doob* and other grasses and form the cold weather grazing lands. Cattle are sent to graze on these lands from long distances.

In the Western Districts, where a better class of cattle is kept, the cultivators grow fodder crops which are partly fed green and partly made into hay. From November to April, the cattle are given chopped *jowar* or *bajra* fodder and the straw of pulses. From May to October, wheat and barley *bhusa* are given supplemented by cotton seed, oil cake or some cheap grain, the latter only when the cattle are doing hard work. In the Eastern Districts, where holdings are small and the cattle poor, the cultivators only give their cattle dry fodder at night supplemented by what they get and pick up during the day when turned out to graze.

'January to June are the months during which there is the greatest difficulty in obtaining fodder. This period is followed by the rainy season when in normal years sufficient fodder is obtainable. If, however, the monsoon fails, the fodder crops fail also. In such a fodder famine the people are helpless and a large number of cattle starve to death. It is not unusual for even good cattle to be sold for half their value during such a period of scarcity. Some cultivators send their cattle to the forests, low-lands or hill-sides to graze but these places soon become over-crowded. A limited number of cattle, however, are thus saved from starvation.

Even in normal years there is not sufficient fodder for the existing cattle. In addition, the pressing problem of the moment is to increase the number of cattle and to provide better breeds. If no increase is made in the number, the cattle now available, which are already over-worked, must be provided with an ample and a much richer diet. The fodder question is also becoming more and more serious on account of the pressure of population and the gradual encroachment on the grazing land. Attention to the points given below would greatly assist in the solution of this problem:—

(1) The safeguarding of the existing grazing lands from further encroachment.

(2) The improvement of the grazing lands by enclosure, by irrigation (sinking tube wells, repairing old tanks, boring existing wells) and by growing on dry lands drought-resisting crops such as prickly-pear.

(3) The extension of the grazing facilities. This can be done to some extent by sacrificing the interests of forestry to those of cattle breeding, by determining grazing rights, by inducing Courts of Wards to grant permanent grazing concessions and by giving Co-operative Societies long leases of grazing lands.

(4) The utilization of certain plants such as *baisurai* Roshana grass) as part of the food.

(5) The preservation of fodder in silo pits.

(6) The employment of improved methods of storing the fodder and of feeding the cattle.

(7) The spread of private farms all over these Provinces.

(8) The improvement of the manure-making system of the villages and the utilization of cake manures.

(9) The improvement of ravine and waste lands wherever possible.
(10) The confinement of the grazing of nomadic cattle and *Brahmani* bulls to certain fixed areas.
(11) The lowering of the canal rates on fodder crops.
(12) The creation of transport facilities both as regards railway freight and the supply of waggons.

All these recommendations, however, will not be sufficient unless the annual fodder outturn per acre is increased. A good outturn cannot be obtained without good cultivation, good cultivation cannot be given without good bullocks and good bullocks cannot be obtained without an ample supply of good fodder. An ample supply of good fodder therefore appears to me the basis of all agriculture. To talk of improving the cattle without first securing a supply of good fodder is, in a way, putting the cart before the horse. What is required first of all is the growth of good fodder crops in quantity. A good fodder crop is rich in food constituents, is digestible, palatable and a heavy yielder. It should grow rapidly without heavy manuring, and, what is still more essential, it should be easily grown and preserved.

The scarcity of fodder is due to the small outturn per acre as well as to the increasingly congested population. The population cannot be curtailed, nor can it be prevented from increasing, hence we must tackle the question of the small outturn which indicates poverty of the soil. Why is there this poverty? It is caused by the annual removal of crops of which very little is returned to the soil. For instance, a maize crop weighing 3,888 lb. in grain and stalks will, roughly speaking, remove 121 lb. ash, 43 lb. nitrogen, 36 lb. potash and 18 lb. phosphoric acid per acre. If wheat is grown and sold, the loss would amount to nearly 30 lb. nitrogen, 13 lb. phosphoric acid and 9 lb. of potash for every 25 bushels of wheat removed. There will be similar losses if barley is removed. The main solution of the problem lies in increasing the outturn per acre, without unduly decreasing the fertility. This can only be done by intensive cultivation and by growing soiling crops wherever circumstances allow. Soiling crops are cut and fed green whereas fodder crops are frequently mature when harvested and are always fed to animals in the cured form. Since soiling crops are usually harvested a little short of maturity it is often possible to grow two crops on the same land. Soiling is generally adopted in an intensive system of cultivation, that is to say, where culti-

vable lands are dear and scarce and where it is necessary to obtain a maximum yield in a minimum time. By the soiling system, there is (1) less wastage in feeding, (2) less loss than in harvesting mature crops and (3) a more complete consumption of the food. This system effects a great saving in land, for it enables the grower to raise much more food from a given area. Ordinarily, where three acres of grass are required to keep a milch cow in good condition for six months, it would be possible to grow enough soiling food to keep the same cow all the year. Hence a given area will sustain at least twice the number of animals. With the increase of the population, the saving in area effected by using the soiling system will increase in importance, especially in the neighbourhood of large towns. Moreover, since by the soiling system a larger number of cattle can be maintained on a given area, a larger quantity of manure of a superior quality will be obtained than is possible from live stock kept on the pasturing system and less of what is thus made will be wasted. A still further saving in soil fertility can be effected by growing leguminous fodder crops such as lucerne, peas and beans in the rotation. They not only effect a saving in soil fertility but also provide highly nutritious food, being rich in fat and albuminoids.

Another point may be mentioned and that is the importance of cutting fodder for preservation at the right period of growth. The nutritive value of fodder or hay depends on (1) its composition, (2) its digestibility. Young crops, being much richer in albuminoids and containing a smaller portion of indigestible fibre than old ones, are consequently more nourishing. As the composition of hay is largely influenced by the age and condition of the crops when cut, this operation should be carried out immediately full bloom is reached. After this point the quality of the hay deteriorates considerably. A crop which can only be used as it grows or which will deteriorate appreciably on keeping, is badly handicapped in comparison with another, which, though yielding less per acre, can yet be preserved as hay or silage.

17. A FODDER PROBLEM OF THE SURMA VALLEY.

BY

J. N. CHAKRAVARTY, B.A.,

Deputy Director of Agriculture, Surma Valley.

Unlike the conditions in most other parts of India, the main problem in the Surma Valley is to find a fodder crop for the rains—particularly from July to November. The country practically goes under water during this period and the whole of the area is used for growing paddy which is the only crop of the Province during the rains. The houses in most villages stand out like islands. The small area of highland near the homestead is used for seed beds and for growing vegetables. The cattle are herded together in sheds and get neither exercise nor grazing. They subsist on grass collected from big *beels* (miniature lakes) which is brought in boats. The collection entails considerable expenditure and the grass is of a very inferior quality. During the winter the water subsides and the *beels*, full of green grass, are available for grazing. In addition the paddy is harvested in December, and herds of cattle are sent to graze in the fields. There is also plenty of paddy straw. The main problem in this Valley, therefore, is to grow a fodder crop for the rainy months.

At the Karimganj Farm, attempts have been made since 1918 to grow early crops of *jowar* in fields in which *aus* paddy is usually grown. These do not actually become submerged, but become waterlogged in June and July. The seeds were sown immediately after the first showers, but as soon as the land became water-logged the growth of the *jowar* was arrested and the crop rarely grew more than four or five feet high and gave a very poor outturn. It is now proposed to sow the crop in January immediately after the paddy harvest. It is hoped that the seeds will germinate after the first shower and that the plants will grow vigorously enough to attain a good height before water-logging sets in.

Any suggestions about fodder crops which may be tried under these semi-aquatic conditions will be greatly appreciated.

18. BROOM CORN—A NEW FODDER CROP.

BY

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Economic Botanist to the Government of Assam.

Three varieties of Broom corn (Standard, Acme and Dwarf) received from the United States have been tried at Karimganj, Shillong, Jorhat and the Demonstration Farm at Haflong Hill. The results obtained may be summarized as follows:—

1. Karimganj. All the varieties grew fairly well. Both the Acme and Dwarf showed a good growth, suitable for silage or for feeding green to cattle. The yield of fodder was roughly about 250 maunds per acre.

2. Haflong. All the varieties grew very well, far better than on the Karimganj Farm. As the fodder problem does not arise at Haflong, the crop could be grown for grain like *jowar*.

3. Shillong. The Broom-corn was planted in the same field with maize, but the plants showed a very poor growth and were very late in maturing.

4. Jorhat. All the varieties grew as vigorously as in the southern parts of the United States of America. The standard attained a height of about thirteen feet, while both the Acme and the Dwarf showed a luxuriant growth. The yield of fodder was roughly about 200 maunds per acre.

Further trials will be made next year. As Broom corn, especially the Acme and Dwarf varieties, matures for fodder in two months, it may prove useful as an early fodder crop in the Assam Valley. The straw can be used for brooms and brushes for which there is always a demand.

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